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AN ASSESSMENT OF PESTICIDE RESEARCH PROJECTS

Funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee

1981 - 1982

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Ontario

The Ontario
Pesticides
Advisory Committee

Hon. Keith C. Norton, Q.C.,
Minister

Gérard J. M. Raymond
Deputy Minister

Date Due

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An assessment of pesticide research projects : funded by the ministry of the environment through the Ontario pesticides

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MINISTRY OF THE ENVIRONMENT
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HAZARDOUS CONTAMINANTS
OFFICE

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AN ASSESSMENT OF
PESTICIDE RESEARCH PROJECTS
FUNDED BY
THE MINISTRY OF THE ENVIRONMENT
THROUGH
THE ONTARIO PESTICIDES ADVISORY COMMITTEE

1981-1982

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RESEARCH PROJECTS FUNDED THROUGH THE ONTARIO PESTICIDES ADVISORY COMMITTEE

1981-82

I. SUMMARY

1) In 1981-82, the Ontario Pesticides Advisory Committee continued a program, begun in 1973, of funding research on pesticides. The objectives of the program are:

   a) To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

   b) To determine potential environmental hazards with pesticides currently in use.

   c) To reduce pesticide input into the environment.

2) Thirty-three research proposals totalling $487,638 were received.

3) Twenty-five research proposals were funded with a total value of $291,680.00. Awards averaged $11,667.00 and ranged from $3,700.00 to $50,000.00.

4) Five grants totalling $78,500.00 were awarded for studies on development of alternative pesticides for pest control.

5) Ten grants totalling $127,780.00 were allocated to studies on the behaviour and fate of pesticides in the environment and on potential environmental hazards to non-target organisms.

6) Ten grants totalling $85,400.00 were allocated for studies aimed at reducing pesticide input into the environment, while still achieving effective pest control.

7) The Pesticides Advisory Committee is very satisfied with the research progress made in 1981-82. It recognizes that with the limited funds available the program can be expected to act only as a catalyst in stimulating support by other agencies for research in the broad areas indicated in the Committee's guidelines, for which there is still an urgent requirement.

II. RECOMMENDATIONS

The Pesticides Advisory Committee recommends that:

1) The Ministry of the Environment continue to support research programs directed toward development of pest control programs which will not pose any serious environmental hazard.

2) The Pesticides Advisory Committee continue to supervise this program following guidelines which have been developed.

III. REVIEW OF THE RESEARCH PROGRAM

The Ministry of the Environment first allocated funds to the Ontario Pesticides Advisory Committee to sponsor pesticide-related research in 1973. Results have been summarized in Annual Reports from 1974-1982, inclusive, which are available from the OPAC on request. Results obtained have encouraged the committee to recommend that the research program be continued under its supervision and the committee is gratified that this recommendation has been accepted. The OPAC research budget in 1981-82 was $294,000.

Terms of reference developed by OPAC to govern the awarding of research grants are based on three objectives, i.e., the need to find suitable replacements for pesticides deemed hazardous and restricted for use in Ontario; the need to determine if pesticides in use pose any serious environmental hazard; and the need to develop more effective approaches to pest control leading to a reduction of pesticide input into the environment. The "Application for Research Support" (Appendix I) invited proposals in six general areas relating to these three objectives. Invitations for applications for research support were widely distributed in January, 1981 to personnel in Ontario universities, industry, and government (copies of the mailing list are available on request), with the deadline for applications being February 27, 1981.

Thirty-three research proposals totalling $487,638. were received. Most (29) were from universities/colleges (Carleton, Guelph, Ridgetown College of Agriculture and Technology, Sault College of Applied Technology, Waterloo, Western and York). The remaining applications were submitted by industry or other organizations. (A list of titles of research proposals submitted for consideration by OPAC is available on request). Applications were considered first by the research subcommittee (J. R. Carrow, G. S. Cooper, P. D. Foley, C. D. Fowle, R. Frank, F. L. McEwen, G. R. Stephenson, D. W. Wilson, and C. R. Harris (Chairman), and then by the Advisory Committee. Twenty-five proposals were accepted, valued at $291,680.00. Awards averaged $11,667.00 (range $3,700. t0 $50,000). Most of the grants were awarded to individuals at universities. Disbursement of research funds by organization is summarized below.

Organization	Number of Research Grants Awarded	($) Total Research Funds
University of Guelph	13	173,640.00
University of Western Ontario	6	62,940.00
University of Waterloo	1	10,900.00
Sault College of Applied Technology	1	11,200.00
York University	1	7,000.00
Other	3	26,000.00
	25	291,680.00

Direction and progress of the research program were monitored by the Advisory Committee in several ways. Initially, some applicants were asked to modify their proposals to better meet the research guidelines. Informal contacts between the research subcommittee and some grant recipients were established. In January, 1982, OPAC sponsored a two-day research seminar at which recipients of grants discussed their research results. This meeting was attended by Advisory Committee members and >80 people interested in pesticide-related research. Each recipient of a grant was asked to provide OPAC with a summary of results (Appendix III). Published research reports relating to research sponsored by the Pesticides Advisory Committee are listed in Appendix IV.

Progress made in 1981-82 relative to the objectives of the research program may be summarized as follows:

Objective 1: To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

During the past 12 years environmental concerns have resulted in restrictions in the use of a number of important pesticides in Ontario. In some cases alternative chemicals or approaches to control were available. However, in other instances no adequate alternative control measures were feasible; or the alternative approaches adopted did not prove satisfactory; or the substitute chemicals used presented their own special hazard, e.g. the high mammalian toxicty of some organophosphorus insecticides. In these situations, OPAC has funded research aimed at developing satisfactory methods of pest control. Five grants were awarded under this objective in 1981-82 totalling $78,500.

Biting flies are "nuisance" pests and disease transmitters. The Ministry of the Environment has supported research on biting fly biology and control for several years. In 1981-82 studies on the biology of mosquitoes in southwestern Ontario were continued. Habitat preference of adult mosquitoes was found to vary with the species and time. Other data indicated that development of different species of mosquitoes can be correlated with development of different common plants, suggesting that a model could be developed to provide control personnel with a simple, inexpensive procedure to determine when mosquitoes are hatching and when treatment should be applied. Research on development of a monitoring technique was continued using small wading pools as artifical oviposition sites. In control studies, several chemicals were evaluated as residual sprays for adult control - the pyrethroid insecticides continued to show potential. Studies on development of a pest management strategy for _Culex_ spp. were continued using a Guelph subdivion as a model site. A single, properly timed treatment with Altosid$^{(R)}$ provided at least six weeks satisfactory larval control in subdivision catch basins (22).* In research on development of alternative approaches to mosquito control, _Bacillus thuringiensis_ var. _israelensis_ continued to show promise as a larvicide (22). Further assessment of the feasibility of using planaria to suppress mosquitoes breeding in catch basins indicated that planaria were very effective in suppressing mosquitoes under laboratory conditions. In field studies, planaria were able to overwinter in some catch basins, but not in others (9).

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* Numbers in brackets refer to Abstracts included in Appendix III.

Two new research projects relating to rodent control in orchards were funded. Grower response to a survey questionnaire indicated that vertebrate pests destroyed an average of 2% of their apple trees in 1980-81. In conjunction with this work, studies were initiated in selected orchards to obtain information on size and behaviour of vole populations in orchards and on the effectiveness of control methods and proper timing of control programs necessary to achieve satisfactory vole control (3). A related project was initiated to identify the most effective and economical methods of controlling voles with chemicals. Emphasis is being placed on development of "bait stations" in which effective rodenticides could be used as bait formulations rather than using the broadcast applications of zinc phosphide baits currently recommended (19).

Structural household pests are a concern in Ontario and large quantities of pesticides are used to control them. The carpenter ant is a common pest and a study on its biology and control was supported in 1981-82. Several different colonies of carpenter ants were successfully established for studies on feeding habits, bait attractiveness, and evaluation of insecticide toxicity (2).

Objective 2: To determine potential environmental hazards with pesticides presently in use.

Ten grants, totalling $127,780. were allocated to this objective.

Research on the fate of pesticides in the environment was continued. In a project begun in 1980, laboratory and field studies showed that the systemic insecticide, aldicarb, oxidizes to aldicarb sulfoxide and aldicarb sulfone in soil. Under field conditions, aldicarb residues disappeared quickly from soil. However, persistence of the residues in soil was influenced by soil type and moisture - the residues were more persistent in soil with high organic content or low soil moisture. The persistence of aldicarb in water was pH and temperature dependent (4). Several new studies on the fate of pesticides in the environment were funded. Many studies have shown that pesticide degradation in soil is dependent, to a considerable extent, on microbial action. Most of these studies, done under optimum laboratory conditions, e.g. high soil temperature and moisture, are not typical of Canadian climatic conditions. A proposal to investigate the influence of microbial factors on the rate of microbial degradation of pesticides in soil was supported. First emphasis is being placed on defining the role of temperature on the rate of microbial degradation of some insecticides in soil (24). A study on the persistence and fate of some herbicides in soils under the different climatic conditions encountered in northern and southern Ontario also received support (21). The persistence of the systemic fungicide, metalaxyl, in soil and water received attention. Laboratory studies showed that metalaxyl was moderately persistent on soil; that soil microorganisms had an important role in metalaxyl degradation; that the fungicide was mobile, with mobility being dependent on soil type; and that it was relatively persistent in water (7). In view of public concern over possible health hazards associated with widespread use of herbicides for weed control in public areas such as parks and schoolyards, a project was initiated, on the instigation of OPAC, to assess hazards, if any, relating to dislodgeable pesticide residues on turfgrass foliage resulting from applications of herbicides for weed control (22). Another research project was begun, also instigated by OPAC, to assess hazards associated with disposal of empty pesticide containers and to develop techniques enabling disposal of pesticide containers in municipal sanitary landfill sites. In a model study conducted at the Thedford Marsh, >3,000 empty pesticide containers were collected during the 1981 growing season. "Empty" pesticide containers often contained small, but potentially hazardous amounts of formulated material, but these residues could, in most instances, be removed satisfactorily using the triple rinse technique or rinsing devices (12).

The potential of pesticides to affect non-target terrestrial and aquatic organisms received further attention. A study, initiated in 1980, to assess the effects of competition between insect pests, such as the corn rootworm, and the honeybee for nectar sites, and hence on honey production, was continued. Low populations of corn rootworm adults and European skippers at the test sites precluded development of any firm conclusions (20). Research on the effects of pesticides on non-target aquatic organisms was continued. Further LC_{50} values for rainbow trout were obtained for herbicides including dicamba, picloram, and EL 171 (15). Two new studies were supported - possible sublethal effects of atrazine on Daphnia were investigated (13); as were the effects of Aquakleen$^{(R)}$ on non-target aquatic microflora and microfauna (5).

Objective 3: To reduce total pesticide input into the environment.

Ten grants, totalling $85,400. were allocated to this objective.

While any grower can testify that pests will damage his crops in the absence of appropriate control measures, there is very little quantitative data available. In 1981-82, a proposal to obtain quantitative data on losses caused by pests to three crops was funded. First year results indicated that, in the absence of appropriate control measures, losses due to insects, diseases, and weeds amounted to 62% reduction in yield of potatoes ($861.32/acre), 89.6% yield reduction of rutabagas ($430.88/acre), and 100% loss of onions ($2,111.40/acre)(16).

Development of effective pest monitoring techniques would often result in more effective pest control with a significant reduction in pesticide use. OPAC considers this to be one of the most practical approaches to reducing pesticide input into the environment and has supported development of pest monitoring programs since inception of this research program. Five projects were funded in 1981-82. Research on apple pest management was begun in 1969 and by 1979 the IPM program was ready for testing on a large scale. A three-year demonstration project was implemented in 1980 through cooperation between the Ontario Apple Commission, Lottario, and OPAC. In the second year of this project: the size of the program was increased; new monitoring techniques for scale insects were tested; control methods for scale insects and mites were evaluated; and a survey for apple scab resistance to some fungicides was initiated (14). Similar emphasis has been placed on development of monitoring programs for vegetable pests with design of weather-timed spray schemes for disease control in onions receiving continued support in 1981-82. While seed treatments with some systemic fungicides did not give satisfactory control of leaf blight or smut in onions, foliar sprays with some protectant fungicides and some systemic fungicides were more effective. Work was continued on development of inexpensive equipment suitable for measuring environmental parameters necessary for disease prediction and a model, based on relationships between leaf wetness and temperature, was developed to predict initial occurrence of leaf blight on onions (10). Assessment of the feasibility of using pheromones to monitor low populations of the spruce budworm in northern Ontario was continued. Low potency traps deployed in 28 areas in northwestern Ontario indicated a dramatic decline in moth catches in 1981, as compared to 1980, suggesting that moth flight and survival were poor, and that larval populations in 1982 will be lower than those occurring in 1981. The effectiveness of different trap designs and of different pheromones were evaluated (17). Two new pest monitoring studies were funded in 1981-82. Results of a study on the timing and effectiveness of sprays used to control white mold on white beans suggested that, contrary to current recommendations, an application of benomyl in late August can reduce white mold on beans, but that the treatment will significantly increase yield only if white mold incidence is reduced by at least 30% (11). Experiments to determine periods of quackgrass interference in soybean development indicated that monitoring leaf temperature differences using infrared thermometry can be useful in measuring periods of crop loss due to weed competition and that quackgrass weed control measures on soybeans should be taken prior to the four-leaf growth stage (6).

Current pesticide application techniques leave a great deal to be desired - more efficient application methods would result in better pest control and less environmental contamination. Large quantities of insecticide are applied in Ontario for corn rootworm control, but the efficacy of these treatments is variable. Poor efficacy has been attributed to resistance, inadequate persistence of the insecticide in soil, and to poor application. In 1981, a study was initiated to determine the cause or causes of poor efficacy of insecticides used for rootworm control. Preliminary results indicated that significant differences in efficacy were obtained depending on application method (8).

Non-chemical or integrated pest control methods may be practical in some situations. As noted earlier, promising results were obtained in mosquito control studies using Bacillus thuringiensis var. israelensis (22) and a flatworm, D. tigrina (9). A non-chemical approach to pest control widely advocated by organic gardeners is the use of companionate plantings. Results of a three-year study designed to obtain quantitative data on the value of companionate plantings for pest control in home gardens generally failed to substantiate popular claims that companion plants will repel insects and disease organisms. While some reductions in pests occurred in some companion plant-crop associations, these reductions were seldom below economic thresholds. Competition between the crop and vigorous companion plants may reduce crop yield. And, though acceptable yields of some crops may be realized without using pesticides, the quality of the crops was substantially poorer than that obtained with crops receiving recommended pesticide treatments (25). Assessment of the feasibility of using parasites and predators in a program of integrated control of the onion maggot was continued. Over 60 native species of predators and parasites have been identified; mass rearing techniques have been developed for two of these species; the susceptibility of two parasite species to insecticides recommended for onion maggot control is being determined; and field trials are being done to assess the potential of parasites and predators for suppressing onion maggot populations (23). In a new study funded in 1981-82, the feasibility of using a naturally occurring smut for suppression of fall panicum, an annual grass which has become a serious weed in corn in southwestern Ontario, was investigated. Samples of two types of fall panicum smut were collected in the fall of 1981. Attempts to infest fall panicum, proso millet, sandbur and corn with the two types of fall panicum smut and two types of corn smut are underway (1).

IV. ASSESSMENT

Good research progress is being made on some of the problems falling within the first research objective. With strong support from the Ministry of the Environment, a productive research program on biting fly biology and control has been developed. The biology of important mosquito species is being studied and techniques for locating breeding sites and for monitoring mosquito populations are being devised. Larval and adult chemical control measures to replace previous organochlorine insecticide recommendations have received attention. Effective organophosphorus insecticides have been registered as larvicides. Narrow spectrum insect growth regulating chemicals and biological control agents have shown promise experimentally for larval control. Broad spectrum pyrethroid insecticides are very effective against adults and, at the low application rates used, would be unlikely to have detrimental environmental side effects. Development of integrated control programs for mosquitoes will take some time, but as data obtained in one model study over the past two years show, population monitoring and properly timed use of a narrow spectrum control agent may be feasible in some situations. As disease vectors and nuisance pests, biting flies constitute a serious problem in Ontario and the productive research program which has been developed in recent years merits strong support from appropriate provincial and federal agencies.

Structural and household pests also are important problems in Ontario. Control measures taken to control these pests involve substantial pesticide use. In contrast to progress being made on biting fly control, information on the biology of structural and household pests in sadly lacking. Current control recommendations, which in some instances still involve use of persistent organochlorine insecticides, need to be revised, yet there are few alternative chemicals available, and these options will become even more limited in the future as pests, such as cockroaches, become resistant. Projects, such as research on biology and control of the carpenter ant, currently being supported by OPAC have begun to provide some information,but more emphasis on this aspect of urban pest control is necessary in Ontario. It is to be hoped that qualified researchers will develop an interest in this problem and that concerned agencies will support their research proposals.

Vertebrate pests can be a serious problem in both urban and rural environments. The Ministry of the Environment has provided significant research support in recent years to studies on vertebrate biology and control, as exemplified by the research projects on vole control which were funded, in part, by OPAC in 1981-82. It is to be hoped that the limited funding made available by OPAC will stimulate further research activity and research support by interested agencies.

Under the second objective, good progress has been made in the past decade in defining the fate and behaviour of insecticides in the Ontario environment. Organochlorine insecticide residues are declining and research has shown that organophosphorus, carbamate, and pyrethroid insecticides are subject to chemical and biochemical degradation in soil and water and that they are not accumulating in the environment to any significant extent. In previous reports, the committee has expressed concern over the fact that some of the newer pesticides tend to be moderately persistent in soil and relatively soluble in water, which suggests that these chemicals may have the potential to contaminate water. Research, being sponsored on the fate and behaviour of aldicarb and metalaxyl, both very water soluble pesticides, mirrors this concern. Microbial degradation has an important role in the degradation of many pesticides and environmental factors undoubtedly influence microbial activities. For example, pesticides may degrade more rapidly in soil or on foliage in southern Ontario as compared to the cooler regions of northern Ontario. Laboratory and field studies on the factors influencing the degradation of pesticides under different environmental conditions should provide some necessary answers. Two areas of public concern with pesticides involve the widespread use of herbicides in public areas such as parks and disposal of pesticide containers. The research currently being sponsored on the extent to which residues of herbicides applied to turfgrass are dislodgeable and on possible hazards associated with pesticide container disposal should answer some of these concerns. In general, less emphasis has been placed on environmental studies with herbicides and fungicides and more research on the environmental fate of these chemicals is justified.

The third research objective, that of reducing pesticide input into the environment is an important goal. Pesticide use can be justified on the basis of quantitative crop loss data. Striking information on pest losses occurring with three crops in the absence of appropriate control measures was obtained in 1981-82. Two of the most promising approaches to reducing pesticide use involve development of pest monitoring techniques and improvement of application procedures. Five pest monitoring programs were funded in 1981-82, ranging from feasibility studies to large-scale demonstration programs. Control measures recommended for corn rootworm in Ontario involve substantial pesticide use. First-year results of a study on the effectiveness of these recommendations suggest that more efficient application methods would provide better rootworm control. While integrated or non-chemical methods of pest control are commendable objectives, there is a need to separate fiction from fact. The completed three-year study on the value of companionate plantings for pest control in home gardens quantitatively demonstrates that this technique, highly touted in the popular press, has little practical value. In a more optimistic vein, progress is being made in studies on the feasibility of developing integrated pest management programs for insect pests such as mosquitoes and the onion maggot and for weeds such as fall panicum.

The Pesticides Advisory Committee is pleased with the research progress made in 1981-82 and recommends continuation of the program. The committee recognizes that, with the limited funds available, the program can be expected to act only as a catalyst in stimulating support by other agencies for research in the broad areas indicated in the guidelines, for which there is still an urgent requirement.

APPENDIX I. Format of advertisement inviting applications for research support from the Ontario Pesticides Advisory Committee.

January, 1981

APPLICATION FOR RESEARCH SUPPORT

The Ontario Ministry of the Environment has a limited amount of funds available for 1981 to sponsor research aimed at: 1) determining potential environmental hazards associated with pesticides currently in use; 2) developing alternative pesticides for those deemed environmentally hazardous and thus restricted in use; and 3) developing alternative approaches to pest control in order to reduce total pesticide input into the environment. Preference will be given to proposals yielding results in a relatively short time with funds being committed on a yearly basis. Research should be in the context of normal use patterns.

The Ministry invites research proposals in the following areas:

1. Economics of pest control including economic threshold levels of pests.*
2. Studies leading to registration of environmentally acceptable pesticides.
3. Reduction of pesticide use through development of effective pest monitoring techniques; alternative integrated or non-chemical methods of control; or improved application techniques.
4. Studies on toxicology, persistence, fate, and biological significance of pesticides in the environment, with particular reference to pesticides widely used in Ontario.
5. Development of information on time which should elapse between dates of treatment and re-entry into treated areas, and on exposure of agricultural workers and licensed exterminators to pesticides.
6. Development of procedures for safe disposal of pesticides and pesticide containers.

*In The Pesticides Act, 1973, S1(1)20, a "pest" means "any injurious, noxious or troublesome plant or animal life other than man or plant or animal life on or in man and includes any injurious, noxious or troublesome organic function of a plant or animal."

APPLICATION PROCEDURE

Research proposals should be submitted to:

The Chairman
Pesticides Advisory Committee
Queen's Park
TORONTO, Ontario M7A 1A2

Applications should include the following:

1. Title of project.
2. Name, address and affiliation of applicant(s).
3. Discussion of problem--(Applicants applying for continuation of a grant should include a summary of previous progress.)
4. Clear statement of objective(s).
5. Plan for program.
6. Facilities available.
7. Budget - categorize costs as : Personnel - full-time and part-time, equipment, supplies, overhead costs, other.
8. Listing of current projects and other sources of funding.
9. Curriculum vitae on principal investigator(s) (if not already on file with the Pesticides Advisory Committee).

Applications should be received by February 27, 1981.

APPENDIX II. Research Projects Supported by the Ontario Pesticides Advisory Committee, 1981-82

No.	Applicant	Location	Project Title	Amount Granted
1.	Alex, J. F.	University of Guelph	Smut on fall panicum.	$ 5.500.00
2.	Blaine, W. D.	Chemical Research International	A study of the control of the carpenter ant.	6,000.00
3.	Brooks, R. J. Gilbert, F. F. King, W.	University of Guelph	Control of voles in Ontario orchards.	5,000.00
4.	Chapman, R. A. Harris, C. R.	University of Western Ontario	Behaviour of aldicarb (Temik$^{(R)}$) in soil.	14,900.00
5.	Coleman, B.	York University	Dynamics and persistence of the herbicide Aquakleen$^{(R)}$ in small artificial ponds and its impact on non-target aquatic microflora and microfauna.	7,000.00
6.	Dekker, J.	University of Guelph	Weed monitoring techniques for the detection of specific periods of crop interference to reduce or eliminate herbicide usage.	5,000.00
7.	Edgington, L. V.	University of Guelph	Persistence of the systemic fungicide, metalaxyl, in soils	12,700.00
8.	Ellis, C. R.	University of Guelph	Determination of the cause of poor efficacy of insecticides used for control of rootworms.	7,800.00
9.	George, J. A.	University of Western Ontario	Control of mosquitoes with planaria.	5,000.00

No.	Applicant	Location	Project Title	Amount Granted
10.	Gillespie, T. J. Sutton, J.C.	University of Guelph	Weather-timed fungicide schemes for vegetable crops.	$ 9,500.00
11.	Hall, R.	University of Guelph	Timing and cost-effectiveness of sprays to control white mold on white bean.	5,300.00
12.	Harris, C. R. Miles, J. R. W.	University of Western Ontario	Development of an acceptable procedure to allow disposal of pesticide containers in sanitary landfills	12,440.00
13.	Kaushik, N. K.	University of Guelph	Evaluation of sublethal effects of permethrin, atrazine and methoxychlor on zooplankton under natural and laboratory conditions.	9,140.00
14.	Ker, K. MacKay, C. Thistlewood, H.	Apple Commission	I.P.M. in Ontario.	7,500.00
15.	Mayfield, C.	University of Waterloo	Toxicity of herbicides to rainbow trout.	10,900.00
16.	McLeod, D. G. R. Tolman, J. H.	University of Western Ontario	Losses in production of potatoes, rutabagas, and onions attributable to insects, diseases and weeds	8,800.00
17.	Sanders, C. J.	The Sault College of Applied Arts and Technology	Development of sex attractant traps for monitoring changes in low density spruce budworm populations as a means of implementing early intervention management strategies.	11,200.00
18.	Sears, M. K. Stevenson, G. R.	University of Guelph	Dislodgeable pesticide residues on turfgrass foliage in relation to safe re-entry.	34,500.00

No.	Applicant	Location	Project Title	Amount Granted
19.	Siddiqi, Z.	Chemical Research International	Meadow mouse control in orchards.	$ 12,500.00
20.	Smith, M. V.	University of Guelph	An investigation of the European skipper and the northern corn rootworm as competitors of foraging honey bees	3,700.00
21.	Stephenson, G. R. Solomon, K. R.	University of Guelph	Persistence of phenoxy herbicides in forestry and agricultural soils in southern and northern Ontario	15,000.00
22.	Surgeoner, G. A. Helson, B. V. McEwen, F. L.	University of Guelph	The biology and control of mosquitoes and other biting flies in Ontario	50,000.00
23.	Tomlin, A. D. Tolman, J. H.	University of Western Ontario	Feasibility of using parasites and/or predators in a program of integrated control of the onion maggot	14,300.00
24.	Tu, C. M. Miles, J. R. W.	University of Western Ontario	Influence of environmental factors on the rate of microbial degradation of pesticides in soil and water.	7,500.00
25.	Wukasch, R. T.	University of Guelph	Effect of companion planting on pests in the home garden	10,500.00
			TOTAL:	$ 291,680.00

APPENDIX III. Progress reports (Abstracts) on projects funded by the Ontario Pesticides Advisory Committee, 1981-82

1. Alex, J. F., Brisson, P. and Smereka, K. - Smut of fall panicum and related grasses.

Fall panicum, *Panicum dichotomiflorum* var. *geniculatum*, an annual grass which has become a serious weed in corn in southern Ontario during the past 14 years, is occasionally infected by a naturally occurring smut. According to G. W. Fischer (1953. Manual of the North American Smut Fungi), the causal organism is *Sorosporium cenchri* Henn. 1896, = *Sorosporium syntherismae* (Peck) Farl. 1891, = *Ustilago syntherismae* Peck 1875). He reported its hosts to be sandburs, *Cenchrus* spp. (probably also including our *C. longispinus* of southern Ontario) and eight species of *Panicum* including witch grass, *P. capillare*, fall panicum, *P. dichotomiflorum*, and proso millet, *P. miliaceum*, with a total geographic range from Ontario west to Saskatchewan and south through the USA into Mexico. The taxonomy of this organism is somewhat confused as the generic names *Sphacelotheca* and *Ustilago* have also been used for it and there have been suggestions that it may be the same one which causes smut in corn.

A brief survey was conducted in September, 1981, to collect samples of smut on these grasses and to obtain some indication of the abundance of each. Dr. S. Weaver had reported finding a smutted sandbur near Harrow a few years ago but we were unable to find any infected sandbur in that same locality in 1981, nor at several other localities where the weed was seen. Smutted plants of proso millet comprised less than 1% of the plants in our research plots at the Arkell Research Station in 1980 and 1981, and we did not observe smutted proso millet in other stands of this weed elsewhere in the province. Smutted plants of fall panicum were very rare when this disease was first observed in Ontario cornfields in the early 1970's, but these have been increasing, both in numbers of fields where they occur and in frequency of occurrence within infected fields. In 1981, 10% (6% to 14% of 7 to 20 plants/m^2) of the fall panicum plants along the margin of a corn field on sandy loam near Ridgetown were smutted, whereas 55% (16% to 100% of 4 to 18 plants/m^2) of plants within the field were smutted. Near Harrow, also on light soil, the respective percentages were 10% outside the corn but only 2.3% inside the field. Near Kingsville, in disturbed land around a corn crib, 53% of the plants were infected. Smutted plants ranged from 15 to 190 cm in height but non-smutted plants were equally variable. In one field the smutted plants appeared to be slightly more vigorous (stems thicker, leaf blades wider) than the non-smutted plants but measurements were not taken.

Two types of smut symptoms were observed. In one, the whole inflorescence was reduced to an irregular mass of purplish spores, with virtually every inflorescence on an infected plant being destroyed. In the other, the branching pattern and the individual spilelets were still discernible but the florets within the glumes of each spikelet were replaced by small masses of purplish smut spores. Two taxa of smut may be involved.

Attempts at critical identification of the smut samples on hand during the summer of 1981 produced uncertain results. Published techniques for spore germination generally led to severe contamination of the plates but this was eventually overcome by using streptomycin. The dark brown colour and polyhedral shape of the smut spores from fall panicum were characteristic of *Sorosporium*, and so was the branching of the germ tube following germination. However, considerable variability was encountered, suggesting a mixture of smut taxa. Attempts to infect proso miller (3 seed colours), fall panicum, sandbur and corn with the two types of fall panicum smut and two types of corn smut are currently in progress.

2. Blaine, W.D. - Control of the carpenter ant.

Eight colonies of the carpenter ant Camponotus herculeans, variety noveboracensis and one colony of the carpenter ant Camponotus pennsylvanicus were established to be used to conduct studies on control of this pest. Camponotus herculeans is the major carpenter ant pest in this area. These colonies are set up in plastic containers and are being used to study population sizes, feeding habits and will be used later to test new insecticide bait formulations.

Two other large colonies are being kept in logs and are being used in screening tests and bait attractiveness tests. These ants have been collected from fence posts in the Toronto area.

A Potter laboratory spray tower has been set up and adjusted to carry out the screening tests. The chemicals that are being tested are diazinon 1%, Dursban 0.5%, Ficam 1.0%, Baygon 1%, cypermethrin 0.1%, and permethrin 0.1%. These last two chemicals may also be tested at other concentrations as their relative toxicity to ants is not known. Glass plates have been sprayed with the chemicals to be tested. These are being aged and then the residual effectiveness will be tested after one, two, three and four months. These are being aged under protected conditions and also under exposure to the environment. This will indicate which chemicals can be used for carpenter ant control inside and outside buildings.

The use of baits for control of carpenter ants is also being investigated. Baits are being formulated from the insecticides AC 217,300, dimilin, and methoprene. Baits will also be formulated from Dursban and Baygon to investigate their action. Most baits that are used for insect control are made using a substance such as bran or corn grits as the carrier. However, tests that were carried out using corn grits as a food source showed that 74% of the ants died compared to only 2% that were fed on a honey and bran diet. Because honey leads to problems with molds, raspberry extract which is highly attractive to carpenter ants will be used to formulate the baits.

3. Brooks, R.J., and Struger, S. - Extent and control of vole damage in Ontario orchards.

A survey of vole damage in Ontario apple orchards was initiated in July 1981. Questionnaires were distributed to growers throughout the province to determine distribution and level of damage caused by vertebrate pests and to assess the variety and efficacy of present control measures. Damage levels were compared among four regions of the province and according to application of various control measures. Small mammal populations were sampled regularly by live and snap trap techniques in several orchards from three areas (Grey-Bruce; Haldimand-Norfolk and Prince Edward counties).

Responses from 280 growers indicated that vertebrate pests destroyed 2% (17,822) of their apple trees in 1980-81. Damage by voles was highest in Georgian Bay and eastern Ontario, but no clear patterns of distribution appeared. Loss of

6. Sikkema, P.H., and Dekker, J.H. - Weed monitoring techniques for the detection of specific periods of crop interference to reduce or eliminate herbicide usage: Determination of critical quackgrass induced stress periods in soybeans with infrared thermometry.

Three experiments were performed at the University of Guelph to determine periods of quackgrass interference in soybeans, and herbicidal suppression of quackgrass. Firstly, a traditional serial weed removal experiment was performed in which the quackgrass was removed at two week intervals through the growing season. This experiment quantified yield losses through the growing season to determine the economic threshold of various control practices. The weeds were removed using both mechanical and chemical methods. Secondly, daily infrared thermometric monitoring of canopy temperatures during the growing season was performed to determine critical stress periods. Thirdly, experimental post-emergence grass herbicides were applied at 0.25 and 0.125 the recommended rates (ca. 1.0 Kg/ha) to determine if quackgrass suppression during the critical soybean stress periods would alleviate crop stress due to weed competition.

The three experiments were positioned adjacent to one another in a field heavily infested with quackgrass. On May 19 the area was sprayed with trifluralin and metribuzin at a rate of .75 and .5 kg/ha respectively, to control both annual grasses and broadleaves. Soybeans, cv "Maple Arrow" were planted on May 26 in 32 cm rows at a rate of 15 to 16 seeds per metre. The following experimental herbicides TF 1169, BAS 9052, RO 13-8895, HOE 00650, DOWCO 453X, and NCI 96683 were applied on July 15 at a rate of .125 and .25 kg/ha. In addition, weekly leaf tissue samples were obtained from the weedy and weed-free check plots and analyzed for nitrogen, phosphorus and potassium content. Yield data was based on the harvested dry weight of the centre four rows, six metres long on October 16.

Significant soybean stress as monitored by leaf temperature, reduction in crop yield, and leaf tissue content of nitrogen and phosphorus occurred when the quackgrass was in the four leaf stage. If the quackgrass remained until the five leaf stage, yield losses of greater than 50% of the weed-free check were observed. There were no further significant losses in soybean yield after the quackgrass was in the five leaf stage. A summation of the "stress degree days"

$$\text{SDD} = \begin{array}{c}\text{Plant}\\ \text{Canopy}\\ \text{Temperature}\end{array} - \begin{array}{c}\text{Ambient}\\ \text{Air}\\ \text{Temperature}\end{array}$$

correlated with crop yield loss revealed an inverse relationship significant to the $.01<p<.005$ level. Soybean yield levels from the plots where the experimental herbicides were applied at the sublethal rates were not significantly different from the weedy check.

Therefore on the basis of one year's data the following conclusions can be made. Firstly, monitoring of leaf temperature differences by means of infrared thermometry can be a valuable tool in measuring time of crop stress due to weed competition. Secondly, any method used for weed control in soybeans must provide effective quackgrass control prior to the four leaf growth stage.

7. Edgington, L.V., and Sharom, M.S. - Persistence of the systemic fungicide, metalaxyl, in soils.

Metalaxyl was applied to three crops (potato, lettuce and soybean), where we believe it has an important potential for disease control. The potato and lettuce were sprayed with a mixture of metalaxyl (0.2 kg/ha) and mancozeb (1.6 kg/ha). Potatoes received four sprays at 12 day intervals and the crop was harvested and tubers analyzed. A trace (0.02 to 0.04 μg/kg) was found in tubers. This was the surface 1^{-2}mm. Since the metalaxyl is mobile in this soil (Fox sandy loam) it may be leached rather than translocated to the tubers. Soybeans had the metalaxyl applied in the seed furrow. The beans are currently being analyzed. The adsorption of metalaxyl on four Ontario soils was investigated. The distribution coefficients (μg adsorbed per gram of soil divided by μg per ml of solution) obtained from the slopes of the adsorption isotherms were 0.42, 0.89, 1.05 and 21.33 ml/g for Fox sandy loam, Honeywood soil, Guelph loam and Bradford muck, respectively. The mobility of the fungicide in the four soils was compared in soil columns. Metalaxyl was most mobile in Fox sandy loam>Honeywood soil>Guelph loam>Bradford muck. The fungicide leached through the 20 cm Fox sandy loam with 10 cm of rainfall, but not through the other three soils. Persistence studies indicated that the metalaxyl was stable in waters of pH 3, 5, 7 and sterilized and unsterilized lake water with more than 95% of the initial amount remaining in solution after four weeks. However, it was degraded in water of pH 10 to approximately 50% of the initial amount after four weeks. Studies on metalaxyl degradation in soils indicated that the chemical was fairly persistent with approximately 50% of the initial amount remaining in the unsterilized Guelph loam and Bradford muck after 4 weeks. More than 90% of the applied fungicide remained in the sterilized soils indicating that microorganisms played an important role in degradation of the chemical.

8. Ellis, C.R. - Determination of the cause of poor efficacy of insecticides used for control of rootworms.

Poor efficacy has been attributed to resistance, inadequate persistence of insecticide and to poor application. The emphasis in 1981 was on evaluating methods of application. A prerequisite for evaluating different methods of application was obtaining a reliable method of recovering larvae from large amounts of soil so as to evaluate efficacy. An extractor was constructed that recovered greater than 85% of larvae and which extracted up to 400 l of soil/day.

To evaluate application methods, more must be known about the distribution of the target rootworms in the soil. In one location where distribution was studied in detail, only 52.9 ± 11.6% of the larvae were within 7.5 cm of the corn plant (that is, within the 15 cm band that is treated with insecticide) 20.8% were between 7.5 and 15 cm, 12.7 were between 15 and 22.5 cm and 24.0% were between 22.5 and 30 cm from the corn plant. Because knowing the larval distribution is fundamental to the interpretation of efficacy, a student has begun a project at Guelph using the extraction equipment to determine the distribution of both northern and western corn rootworms in the soil in relation to soil type and moisture.

Different methods of application were tested on three farms where large populations of rootworms were expected. On one farm, 80 plots were used to test four replicates of three insecticides applied with a precision applicator either not banded, or in 15 or 30 cm bands and with or without drag chains. On two other farms, the farmer's own equipment was used to test three insecticides with or without 15 cm spreaders either with or without drag chains.

Effectiveness was tabulated from larvae recovered from soil, from per cent goosenecking and from yield. The data were preliminary and a minimum of three years of data will be required before conclusions can be made. However, significant differences in efficacy were obtained. For instance, the efficacy of Counter was 44% less in 30 cm bands than in 15 cm bands. Obviously, rates per unit area became too low when the bands were too wide. Such wide bands can easily result from drift, especially when spreaders are mounted too high and without protection from wind.

Adult northern and western corn rootworms were collected from several fields including one where poor control had occurred. A primary screen for resistance done at the Agriculture Canada laboratory at London, Ontario, did not indicate resistance. However, there is poor correlation between resistance of larvae and that of adults and because small changes in susceptibility could account for failure of control in the field, the possibility of resistance has not been ruled out. More experiments with larvae under controlled conditions will be required.

9. George, J.A. - Control of mosquitoes with planaria.

Planarians in catch basins: In July, 1980, 80 planarians were placed in each of 27 catch basins in Komoka and Mt. Brydges where they persisted, in all but one, until last inspected in 1980 on October 31.

Weekly inspections from May 15 until August 21, 1981, revealed that planarians had overwintered in 18 of the original 27 catch basins. None was found in the remaining nine catch basins which included the one from which planarians had disappeared the previous year.

On August 28, 1981, the nine catch basins without planarians were each restocked with 25 new planarians. Their presence in all nine catch basins, four weeks later, proved the water to be non-toxic at that time.

The failure of planarians to winter in all catch basins was not related to pH, depth of water or presence of oil. It could have been due to a temporary low level of oxygen, toxic chemicals, excessive flushing or some other unknown cause.

Efficacy of predation in laboratory: In laboratory tests, replicated six times, 100 first instar Culex larvae were placed in each of six containers with two liters of water and one of 0, 1, 2, 4, 8 or 16 planarians. Even though over 90% control was achieved with four or more planarians, an average of 1.3 mosquito adults still emerged from the containers with 16 planarians.

With 500 (two replicates), 1000 (four replicates) or 2000 (four replicates) first instar Culex larvae and 80 planarians in 12 liters of water, averages of only 15%, 9% and 6% respectively of the larvae reached adulthood. When the numbers of adults which emerged from containers in spite of planarians, were compared with those from containers without planarians, it was calculated that planarians achieved an overall average control of 88%.

Planarian on floats: Extensive tests failed to establish a relationship between the numbers of planarians on floats, and other variables such as the presence or absence of food, time of day, temperature, or light and dark periods. The numbers present on the floats appeared to be random.

Reduced egg rafts in oviposition pools: The SR-10 formulation of methoprene, plus five *Culex* egg rafts allowed to hatch daily, in a oviposition pool, decreased oviposition by wild females to less than 2 egg rafts per day, compared to 20 per day in an adjacent control pool, over a three week period. The decrease was caused by the large number of larvae, which never reached adulthood, rather than a repellant effect of methoprene. It is not known if the larvae decreased oviposition by means of agitation or chemical secretions.

Coccoons: Coccoons were produced by a purchased sexual strain of planarians, after chilling, but the local strain could not be induced to produce coccoons.

10. Gillespie, T.J., and Sutton, J.C. - Weather-timed schemes for vegetable crops: Tests of systemic fungicides on onions and development of weather monitoring devices for IPM.

Several systemic fungicides were tested for effectiveness against *Botrytis* leaf blight of onion: (1) as seed treatments, to delay leaf blight epidemics, and thereby reduce the need for foliar sprays; (2) as weather-timed foliar sprays applied after infection periods (thus eliminating prediction of infection periods) and allowing minimum spray intervals of 14 days. Effectiveness of the systemic fungicides was compared with that of weather-timed applications of two protectant fungicides (Rovral 50 WP and Bravo 500) preceding infection periods, and allowing a 10-day minimum spray interval. Experiments were conducted in field plots at the Muck Research Station, Bradford and at the Arkell Research Station.

Seed treatments used were CGA 64251 (0.025 and 0.050 g AI/kg seed), Baytan 7.5 L (0.15 g AI/kg), Baytan 10D (0.30 g AI/kg) Ease-Out (25 g AI/kg) and, as a check, Pro-gro (20 g AI/kg). The systemic fungicides failed to delay the epidemic progress of leaf blight and to control smut. Leaf blight intensity reached the visual threshold (1% disease) on 7 July (Bradford) and 9 July (Arkell) or about 9-10 wk after sowing in all treatments.

Foliar treatments were Rovral 50 WP (750 g AI/ha), Bravo 500 (1500 g AI/ha), CGA 6420 (125 g AI/ha) and Bayleton (250 g AI/ha). Four applications of the protectant fungicides (Rovral, Bravo) and two applications of the systemics (CGA 64250, Bayleton) were used. All treatments controlled leaf blight effectively, even though disease was severe in nonsprayed check plots. Effectiveness of the systemic fungicides was deteriorating 27 days after the second application. Thus, the two systemic fungicides may be used effectively as weather-timed, post-infection period sprays for leaf blight.

Other data on relationships of leaf wetness and temperature to the infection cycle of *Botrytis squamosa* have been used to develop a model called BOTCAST to predict initial occurrence of leaf blight.

Adaptation of research results on spray timing to operational use in growers' fields requires inexpensive and highly reliable instrumentation to monitor temperatures and moisture. In cooperation with two Ontario companies, two microprocessor-based, battery-powered devices have been built for this purpose. The simpler device (monitors air temperature and wetness duration) has passed initial tests and is expected on the market in spring 1982, while the second device (monitors soil temperatures in addition) is under continued development.

11. Hall, R., and Morton, J.G. - Timing and cost effectiveness of sprays to control white mold on white bean.

The purpose of our experiments was to determine the effect of time of application of a recommended product, Benlate 50W, on severity of white mold in white bean and on yield of seed. Randomized complete block experiments were conducted at three locations. At Arkell small plots ($7.5m^2$) were sprayed at the rate of 2270L/ha with a backpack sprayer. In unsprayed plots 62.5% of the plants had white mold on September 4. One spray on August 7 did not significantly reduce disease or increase yield.

However, one spray on July 29 (full bloom) or on August 13, or on August 18 significantly ($P = 0.05$) reduced disease by 55%, 50% and 62% and increased yield by 54%, 42% and 47% respectively. Five sprays applied at weekly intervals between July 23 and August 20 reduced white mold incidence by 81% and increased yields by 57%. Generally speaking a 5% increase in yield will pay for the cost of the spray. These results indicated that a spray either during the blooming period or in mid to late August could provide economic returns. Two tests on a field scale were conducted.

At Mitchell, plots $189m^2$ in area were sprayed using a commercial Hiboy sprayer that delivered 243L/ha at 84 psi (579 kPa) through two drop nozzles and one overhead nozzle per row. Spray applied at full bloom (July 23) did not significantly affect yield or white mold incidence. Spray applied on August 11 significantly reduced disease incidence from 67.7% (Check) to 46.3% on September 8, but did not affect yield.

At Ailsa Craig plots 0.38 ha in area were sprayed using a tractor-pulled FMC sprayer which delivered 364 L/ha at 200 psi (1379 kPa) through hollow cone nozzles mounted above the crop. A spray applied at full bloom (July 31) did not significantly reduce disease. However, one spray applied August 19 or two sprays applied July 31 and August 19 significantly reduced disease by 18% and 23% respectivel Because of poor harvesting conditions, yields could not be determined.

These results indicate, contrary to current recommendations, that an application of Benlate in mid to late August can reduce the incidence of white mold in beans under experimental and commercial conditions. Apparently however, the spray treatment will significantly increase yield only if the incidence of white mold is reduced by at least 30%. This level of disease control was achieved in small, hand-sprayed plots, but not in large commercially-sprayed plots. Future work in this area should examine ways to avoid wasting effective fungicides. Techniques to improve the efficiency of fungicides for control of white mold on beans in commercial situations are needed.

12. Harris, C.R., and Miles, J.R.W. - Development of an acceptable procedure to allow disposal of pesticide containers in sanitary landfills.

A pesticide container disposal project was organized for the vegetable growers of the Thedford-Grand Bend Marsh. After drilling of 8 test wells showed sufficient clay underlay (as much as 30 ft), permission was granted by OME for the disposal of empty pesticide containers in the Superior Sanitation Land Fill Site (LFS) at Watford, Ont. Letters were sent to the 50 growers instructing them to place their empty pesticide containers on the roadside on the 1st and 3rd Fridays of June, July, August and September. Meetings were held with Bosanquet Township Council to arrange for the use of their packer truck, but on the eve of the first collection, their truck was declared unserviceable. A substitute packer truck (with driver) was rented from the town of Forest and their truck was used throughout the summer. Approximately 3,600 containers (up to and including 5 gallon metal drums) were collected and disposed of at the Watford LFS. A side project was conducted to clean up discarded pesticide containers from growers ditches and fields.

Rinsing of pesticide containers was also studied throughout the 1981 season. A number of rinsing devices (EZ and JET Rinses) were distributed to selected growers. Rinsed containers were collected and acetone was used to dissolve any residue that the growers might have missed. Acetone rinsings were also made from drums rinsed by the recommended "triple rinse." Analyses (by GLC) of the acetone solutions showed that for most materials "triple rinse" and the rinsing devices efficiently transferred the majority of residual pesticides from the container. However, with some formulations (especially parathion EC, and Furadan Flowable) large quantities (up to 200 g pure pesticide from 1 gallon) remained, even in rinsed containers. The Furadan was in the form of approximately 10 mm thick cakes on the bottom of the 1 gallon plastic containers. Essentially our 1981 work showed that most formulations could be efficiently rinsed from the containers, but poor formulations can cause problems such as poor transfer to the spray tank and unsafe amounts discarded in supposedly "empty" containers.

13. Kaushik, N.K., Smith, K.E., and Stephenson, G.L. - Evaluation of sublethal effects of permethrin, atrazine, and methoxychlor on zooplankton under natural and laboratory conditions: Sublethal effects of atrazine on two species of Daphnia.

Two concentrations of the herbicide atrazine were applied on 4 June, 1981, to large-volume aquatic enclosures (limnocorrals) installed in Lake St. George, 32 km north of Toronto. Filtered water collected weekly from the treated and untreated corrals was used in a laboratory experiment to evaluate the chronic sublethal effects of atrazine on reproduction of two species of cladocerans (Daphnia magna and D. galeata mendotae). The laboratory experiment consisted of three treatments - low atrazine (0.2 mg/L), high atrazine (2.0 mg/L) and controls with eight cups in each treatment. Individual organisms were placed in cups containing 300 ml of water from the appropriate treatment. To determine whether the sublethal effects of atrazine were the result of a depleted food supply, a 1 ml aliquot of culture algae (Scenedesmus, Chlorella, Chlamydomonas) was added to four cups in each treatment.

Atrazine, a herbicide with known toxicity to algae, caused a numerical reduction of the larger phytoplankton in the treated corrals at both concentrations. However, numbers of nannoplankton increased in corrals treated with high atrazine. Production (number of young produced per individual in 21 days for D.g. mendotae and 28 days for D. magna) was lower in the atrazine treatments. However, individuals exposed to the high atrazine concentration produced more young than those exposed to the low concentration. The addition of algae neutralized the impact of atrazine in that no significant difference in production occurred between treatments until the third generation when D. magna individuals exposed to high atrazine produced more young. The addition of algae increased production in all treatments relative to those which received no algae.

D.g. mendotae exposed to atrazine reached reproductive maturity before the controls for all generations. With the exception of the third generation, D. magna exposed to atrazine took longer to produce their first brood than the controls. Despite this difference, both species exposed to low atrazine produced young before those individuals exposed to high atrazine. When algae were added to the cups there was no significant difference in maturation time beween treatments.

The rate of production in second generation D.g. mendotae was significantly lower in the atrazine treatments. However, in the third generation there was no significant difference between rate of production of individuals in the high atrazine treatment and the controls. Rate of production in low atrazine remained significantly **lower** than the controls. When algae were added to the cups there was no significant difference between treatments until the third generation, when rate of production was significantly higher in high atrazine treatments. D. magna appears to be more sensitive to the lower atrazine concentration since rate of production was significantly lower than controls despite the addition of algae. The rate of production was consistently higher in individuals exposed to high atrazine than those in low atrazine.

14. Ker, K, MacKay, C., and Thistlewood, H. - IPM in Ontario: The status of apple pest management in Ontario.

The growing season of 1981 saw an expanded apple pest management project as it had operated in previous years. Additional research projects were undertaken to help overcome program deficiencies.

Resistance to benzimidazol fungicides by the apple scab fungus, Venturia inaequalis had been detected previously. A survey of the resistance was initiated in 1981 with spore populations tested at Bowmanville and Simcoe. Results indicated 14 out of 35 orchards exhibited varying degrees of resistance.

Due to extensive scale damage in 1980, testing of various monitoring techniques occurred in 1981. Commercially available sex pheromone traps for trapping adult males of San Jose Scale, Quadraspidiotus perniciosus and sticky board traps for males of European Fruit Scale, Quadraspidiotus ostreaeformis were tested. Further work is necessary before the techniques can be released for general use.

Control methods for the scale species were evaluated. Superior type oil (70 vis.) did not provide 100 percent control but was sufficient to prevent scales from migrating onto fruit. Due to damage caused by oil emulsions on Red Delicious, a test using methidathion (Supracide) 25 E.C. took place in an orchard where scales had been present on 91.5% of the fruit in 1980. Results proved methidathion a viable alternative to superior oil. The effect of oil emulsions on new cultivars was tested in 1981.

Mite control tests with Torque indicated a suitable material is available where Plictran resistance has been encountered. Use of a micro computer for rapid data analysis proved effective at Simcoe and training on the procedure will be undertaken by the pest management specialists in early 1982.

15. Mayfield, C.I. - Toxicity of herbicides to rainbow trout.

The toxicity of pesticides to rainbow trout, *Salmo gairdneri*, was measured by a standard 96-hour LC_{50} assay. Healthy fish between 35 and 75 mm in length were acclimated for 10 days at 13°C and 30 fish were exposed to at least five concentrations of the pesticides. The total loading of fish tissue per litre did not exceed 1 gram. Mortalities were determined at 6, 24, 48, 72 and 96 hours. General behaviour patterns were also observed. Each series of tests was repeated three times. The pesticides tested to date include Banvel (dicamba), Fluridone (EL 171), Tordon (picloram) as both the commercial formulation and the active ingredient. Banvel (and dicamba) was essentially non-toxic at the experimental limit of 80 ppm. Fluridone gave a LC_{50} of 12 ppm and the active ingredient (EL 171) 14.5 ppm. Tordon (picloram), in preliminary trials, gave an initial value of 4.5 ppm for the LC_{50}. Further tests are required to validate and confirm this last result.

16. McLeod, D.G.R., and Tolman, J.H. - Losses in production of potatoes, rutabagas, and onions attributable to insects, diseases, and weeds.

In order to estimate crop losses under conditions experienced by commercial growers, trials were established at three locations in the London area. Treatments for each crop were replicated four times in a randomized, complete block design.

Potatoes

Kennebec potatoes were planted in a sandy loam near Strathroy on May 25. Significant stands of lambsquarters, ragweed, pigweed, lady's thumb and barnyard grass grew in herbicide-free plots. Although significant populations of potato flea beetle, tarnished plant bug and aphids were recorded in insecticide-free plots at various times during the summer, the most important insect pest was potato leafhopper; vines in untreated plots were totally dead by Sept. 9. Traces of early blight were observed in fungicide-free plots but no significant disease developed. Potatoes were dug Sept. 16-18 and subsequently washed and graded. Results were as follows:

Factor(s) not Controlled	Programme Applied	Average Marketable Yield (tons/ac)	[i]% Yield Loss	Value per Acre ($94.65/ton)	[i]Loss per Acre ($)
All	None	5.57	*62.0	527.20	861.32
None	Complete (IFH)	14.67	-	1,388.52	-
Weeds	[ii]IF	11.72	*20.1	1,109.30	279.22
Insects	FH	7.29	*50.3	690.00	698.52
Diseases	IH	13.84	5.7	1,309.96	78.56

* $p<0.05$

[i] loss relative to complete programme.

[ii] I-insecticide; F-fungicide; H-herbicide

Rutabagas

Laurentian rutabagas were planted in sandy clay loam at the Fanshawe Research Station on June 3. Rather sparse stands of old witchgrass, ragweed and several perennial grasses grew on herbicide-free plots. High populations of aphids in insecticide-free plots in early July caused severe leaf crinkling and plant stunting from which rutabagas generally recovered if weed competition was absent. Significant populations of crucifer flea beetle were recorded in July. Although sweep net samples and flight interception traps recorded high populations of cabbage maggot adults at no time during the growing season significant maggot damage was recorded during grading. Disease was never a problem. Rutabagas were pulled on Sept. 10 and subsequently graded. Results were as follows:

Factors(s) not Controlled	Programme Applied	Average Marketable Yield (bu/ac)	% Yield Loss	Value per Acre ($2.25/bu)	Loss per Acre ($)
All	None	27.0	*87.6	60.75	430.88
None	Complete (IFH)	218.5	-	491.63	-
Weeds	IF	245.5	-	552.38	-
Insects	FH	88.1	*59.7	198.23	293.40
Diseases	IH	217.0	-	488.25	3.38

Onions

Rocket onions were planted in organic soil on the Thedford-Grand Bend marsh on May 8. Dense stands of pigweed, purselane, lady's thumb and barnyard grass completely smothered onions in herbicide-free plots by July 7. Onion maggot adults were first trapped on May 11, reached peak levels the week of June 9 and completed three generations by the end of September. Damaging levels of thrips were recorded in insecticide-free plots by Aug. 13. *Botrytis* lesions were first observed in fungicide-free plots July 17, affected 15%-20% of total leaf area by Aug. 17 and covered over 80% by leaf area by Sept. 7. Onions were pulled Sept. 15, harvested Sept. 24 and subsequently graded. Results are summarized as follows:

Factor(s) not Controlled	Programme Applied	Average Marketable Yield (50 lb bag/ac) #1 Sm.	#1 Lg.	% Yield Loss	[i] Value per Acre ($)	Loss per Acre ($)
All	None	0.0	0.0	*100.0	0.00	2,111.40
None	Complete (IFH)	169.2	431.6	-	2,111.40	-
Weeds	IF	0.0	0.0	*100.0	0.00	2,111.40
Insects	FH	12.2	119.3	* 78.1	549.05	1,562.35
Diseases	IH	133.7	210.6	* 42.7	1,081.40	1,030.00

i-#1 Small-$1.00/bag; #1 Large-$4.50/bag.

It is readily apparent that useful data were collected for all three crops. The work will be repeated in 1982 and perhaps expanded to include determination of potential losses in early potatoes.

17. Sanders, C.J. - Development of sex attractant traps for monitoring changes in low density spruce budworm populations as a means of implementing early intervention management strategies.

In 1981, monitoring of relatively low density spruce budworm populations in Northwestern Ontario with sex pheromone traps continued in 28 locations, which have now been monitored continually since 1975. A ten fold increase in larval populations in 1980 (bringing the population up to about 1 larva per branch tip) was associated with high moth catches, resulting in the saturation of the trapping surface in both low and high potency traps. As anticipated from these high catches larval populations remained relatively high (again about 1 larva per branch tip) in 1981. Only low potency traps were deployed in all 28 areas therefore in 1981, and these showed a dramatic decline in catches, suggesting poor moth flight and survival. We therefore conclude that larval populations in 1982 will be lower than in 1981 in Northwestern Ontario. Trap catches were less uniform over the area than in past years, ranging from less than 1 per trap to 26 per trap. This suggests that while population increases may be uniform over wide areas, population declines may be more irregular. Correlations between moth catch and larval density cannot be made, since trap design and lure potency have not been constant over the whole period.

Alternative trap designs to the sticky bottomed Pherocon 1 CP were tested in 1981. These were a Michigan State University closed funnel trap (CFT), which uses Vapona strips as a killing agent, and a trap designed in Maine using an alcohol/ethylene glycol mixture as the killing/preservative agent (Kendall trap). Like the sticky trap, the CFT showed evidence that some males are repelled as more and more are captured and deteriorate, a phenomenon which reduces the usefulness of the traps. Over prolonged use moisture in the trap leads to decay of the moths, making the catch almost impossible to count. However, these traps do not have a limited capacity as do the sticky traps, and if the problem of moisture and decay can be solved, they may be of value. The Kendall trap had a lower capture rate than the other two, but showed no reduction in efficiency over time. The main disadvantage is that of handling and counting the moths in the liquid, which makes them inconvenient for extensive use.

The effectiveness of two commercial lures, Conrel fibres and Hercon flakes, was compared to the currently used PVC lures. Release rates were designed to be approximately the same. However, differences among catches indicated that release rates were significantly different between the different types of lure. The Hercon flakes showed a much larger decline in potency over one week than the other lures, while the Conrel fibres showed a high variability among lures. If these problems can be overcome then the three formulations can be considered interchangeable, and choice would depend upon cost and/or user preference.

Various layout designs using Pherocon 1 CP traps baited with different potency PVC lures were tested. Results suggest that the use of these traps, baited with two or three different potencies of lure, is still appropriate for early detection of threatening spruce budworm population increases, but further comparisons between the Pherocon 1 CP and non-saturating traps such as the CFT are required in 1982.

18. Sears, M.K., and Stephenson, G.R. - Dislodgeable pesticide residues on turfgrass foliage in relation to safe re-entry.

This project was funded in the latter part of 1981. A progress report is expected in 1983.

19. Siddiqui, Z. - Meadow mouse control in orchards.

Four orchards were selected to conduct studies on control of meadow voles, Microtus pennsylvanicus (Ord). The orchards are located in Orono (Durham), Norval (Peel), Milton (Halton), and in Belwood (Wellington). All the orchards are heavily infested with M. pennsylvanicus, except the one in Belwood which suffered severe tree girdling in 1980.

An experimental plot consists of 60 trees in 6 rows 10 trees long, and the middle five trees in the center two rows are used for the observation purposes. The area of plots varied according to the tree spacing which ranged from 5m to 10m. There are 4-5 rodenticide treatments at each location with three replications in a randomized block design. The inverted 'T' type bait station (originally designed by Radvanyi)was constructed by using a schedule 20 ABS plumbing pipe of 4 cm diameter, a vent tee, and a ABS test cap to cover the station. The cap was painted with fluorescent orange paint for ease in locating the station. The bait station measured 60 cm high and the two sides of 30 cm each. The outer two ends of the pipe were cut at 45° angles to form a canopy. The bait stations are placed at the rate of 25/ha and held by a plastic tie to a 2.5 cm wide wooden peg driven 30 cm deep into the ground. The following rodenticides are being evaluated in the bait stations: (i) Bromadiolone 0.005% in oat grouts; (ii) Brodifacoum 0.005% in pellets; (iii) Chlorophacinone 0.005% in oat grouts; (iv) Encapsulated zinc phosphide 2% in oat grouts; and (v) Waxed Mouse Bait 2, containing 2% zinc phosphide in cracked corn (commercially available). The control treatment consisted of the conventional broadcast of the Waxed Mouse Bait 2 at a rate of 15 kg/ha. The amount of bait per station varied from 500 to 800 gm depending upon the formulation.

This is a long term experiment, therefore, the effectiveness of bait station and various anticoagulant rodenticides will be evaluated in the spring and fall of 1982. Meadow vole population in the experimental plots, before bait station placement, was estimated by live trapping. A modified Sherman live trap with bait was used. Ten traps were placed in the middle of each plot for five consecutive days. Trapped animals were marked by toe clipping and released. Again, thirty days after bait station placement number of voles was recorded by snap trapping.

The live trapping indicated that other than M. pennsylvanicus, Sorex cinereus were present at two locations, and Peromyscus maniculatus at one location. The number of voles live trapped ranged from 6 to 45/plot, while the snap trapping revealed 0.34 to 1.27 voles/site. The bait stations will be monitored at regular intervals and refilled, as and when necessary, to maintain the bait supply.

20. Smith, M.V. - An investigation of the European skipper and northern corn rootworm as competitors of foraging honey bees.

European Skipper

High populations of the European skipper butterfly sometimes occur in certain regions of southern and northern Ontario. During the period in late June and early July, when these butterflies are actively feeding, some beekeepers have complained of a reduction or cessation in the honey flow. In an attempt to obtain information about the possible interaction of skippers and honey bees, a study area was set up near Priceville. Because of a generally poor honey flow, and only a moderate population of skippers, no clearcut relationship could be observed between colony gains and skipper numbers. The skippers did show a feeding preference for blue weed, a nectar source that is of considerable value to bees.

Northern Corn Rootworm

The continuous growth of corn in the same fields has resulted in a very great increase in numbers of the northern corn rootworm. In its larval stage this insect feeds on corn roots, but as an adult the beetle flies to nearby blossoms where it feeds on pollen and petals until it matures and returns to the corn to oviposit.

The beetles sometimes occur in extremely high numbers on such blossoms as goldenrod. On one field trip, near Tiverton, 226 beetles were shaken from one raceme of goldenrod. Blossoms are mutilated, nectar secretions decreased and honeybee foraging limited.

Four honey bee colonies in the main study area at Waterdown were weighed three times a week. Three colonies were fitted with pollen traps to monitor the foraging preference of the honey bees. Since the expected population of rootworm adults failed to develop, there was no correlation between colony gains and rootworm populations. Pollen trap data indicated that the bees foraged to a very limited extent on goldenrod this season.

However, general observations and comments from beekeepers in various parts of southern Ontario indicate that this insect does pose a threat to honey production in the late summer and early fall.

21. Thompson, D.G., Stephenson, C.R., and Solomon, K.R. - Persistence of phenoxy herbicides in forestry and agricultural soils in southern and northern Ontario.

A study is presently being conducted to determine the persistence of 2,4-dichlorophenoxy acetic acid (2,4-D) and 2- 2,4-dichlorophenoxy propionic acid (Dichlorprop) in a variety of soils from Ontario.

Soil types under investigation include:

a) clay loam of agricultural significance in Northern and Southern Ontario.
b) a clay soil and a sandy soil typical of forestry area in Northern Ontario.

Field experiments have been established in a complete randomized block design of four replicates. Data on soil temperature and rainfall have been collected on a continuous basis utilizing remote monitoring devices so that relationships of these factors to persistence can be studied.

Gas chromatographic analysis utilizing electron capture detection is employed to determine residues of free and bound acids.

22. Surgeoner, G.A., Helson, B.V., and McEwen, F.L. - The biology and control of mosquitoes and other biting flies in Ontario.

1. Evaluation of *Bacillus thuringiensis* var. *israelensis* as a mosquito larvicide.

Abbott's WP formulation of Bti (ABG-6108-II, 2000 AA units/mg) was tested in two natural snow melt pools against 3rd-4th instar spring *Aedes* spp. larvae. At 1 kg/ha, 96 and 97% control was obtained in bioassay cages and minnow traps respectively three days after treatment. At 0.75 kg/ha the reductions were 89% and 90%. Non-target crustacean and insect populations were not affected by these two treatments. A simulated pool trial also demonstrated that this formulation was effective against 4th instar *Ae. stimulans* larvae at 1 kg/ha. Treatment of a natural ditch containing 3rd instar *Ae. vexans* larvae at 1 kg/ha resulted in 100% mortality in bioassay cages one day after treatment. However, poor reductions were observed in the minnow traps perhaps because of larval movement from a nearby adjoining untreated area. Laboratory tests have shown that only small differences in susceptibility exist between 3rd instar *Ae. stimulans* (24 hr LC50 = 0.11 AA/ml), *Ae. vexans* (0.07 AA/ml) and *Culex* spp. (0.20 AA/ml) larvae. In susceptibility tests this material was ca. 10 x more toxic at 20°C than at 5°C. Good control of 4th instar *Culex* spp. larvae was obtained at 0.5-0.75 kg/ha in simulated pool trials using this WP formulation. Two experimental granular formulations (ABG-6108-II, floating granule; ABG-6108-II, float-sink granule) were much less effective at equivalent dosages of active ingredient. The toxicity of Bactimos, another WP formulation of Bti produced by Biochem Products (3500 AA/mg), was found to be similar to Abbott's WP formulation. In the laboratory the 24 hr LC50 of different species ranged from 0.1-0.44 AA/ml while good control of *Ae. stimulans* and *Culex* spp. larvae was obtained at 0.5-1 kg product/ha in simulated pools. The toxicity of Tecknar, a liquid formulation of Bti produced by Sandoz Inc. (1500 AA/mg), was also similar to the above formulations with a 24 hr LC50 of 0.21 AA/ml for *Culex* spp.

2. Evaluation of insecticides as residual sprays for backyard adult mosquito control.

In three backyard trials methoxychlor at 2.4 g AI/100 m^2 provided 38-65% ($\bar{x}$ = 49%) control the evening of application and 42-66% ($\bar{x}$ = 52%) control the day after treatment. In one trial, these control levels were maintained for at least seven days after treatment. In two trials, chlorpyrifos at 9 g AI/100 m^2 provided 26% control, the evening of application. Better control apparently was achieved 1 or 2 days after treatment, 62% in the first trial and 69% in the second trial respectively. In two trials, against *Mansonia perturbans* and *Aedes vexans*, carbaryl at ca. 8 or 23 g AI/100 m^2 provided very little control (18% on treatment day; 0% one day after treatment). In small plot trials, carbaryl at 0.25 g AI/m^2 gave a LT50 value of 3.8 days, and 7.1 days at 1.95 g AI/m^2, the recommended dosage. Permethrin 1.25% EC was also tested at different dosages in small plot trials. After 6 hr exposure, the LT50 values at 0.01 g AI/m^2 and 0.05 g AI/m^2 were 3.5 days and 17.8 days respectively indicating that significantly longer residual activity might be achieved by increasing the presently-recommended dosage of 0.00625 g AI/m^2 less than 10 fold to 0.05 g AI/m^2. LT50 values at 0.1, 0.15, and 0.2 g AI/m^2 were 21.4, 25.7 and 26.7 days respectively. In two small plot trials comparing three synthetic pyrethroids, the order of effectiveness was cypermethrin> fenvalerate>permethrin. At 0.00625 g AI/m^2 after 6 hr exposure LT50 values were 10.9, 5.2 and 3.7 days respectively while at 0.01 g AI/m^2 the values were 14.9, 12.5 and 9.5 days.

3. A pest management strategy for *Culex* spp. control.

Previous research on the residual activity of methoprene against *Culex* spp. and the time of diapause induction in these mosquitoes indicated that one properly-timed Altosid treatment after the first generation of *Culex restuans* and *Cx. pipiens* had reached fourth-instar larvae should control populations of these mosquitoes for the entire season. This strategy was tested in a Guelph subdivision where catch basins were a major breeding source for these mosquitoes. Altosid SR10 at 0.4 g AI/basin was applied to all basins in the subdivision on June 1, 1981. This treatment provided at least six weeks good control of larvae in these basins. Oviposition pools were used to monitor the effects of this treatment by comparing the number of egg rafts laid in the subdivision to other untreated areas in Guelph. Overall control of both species was 48%. By month, 36% control was achieved in June, 48% in July and 71% in August. Apparently, *Cx. pipiens* populations were controlled better than *Cx. restuans* with overall control of the former being 71% compared to 36% for the latter.

4. Further assessment of oviposition pools for monitoring *Culex* spp. populations.

As in 1979 and 1980, children's wading pools were set up in the same locations in Guelph to evaluate their usefulness for monitoring *Culex* spp. populations. In 1981 much larger numbers of egg rafts were collected from the five pools during the season: 1575±253 (SE) compared to 522±162 in 1980 and 899±159 in 1979. The mean weekly relative variation between pools was 10.2% in 1981 compared to 19.3% in 1980 and 17.5% in 1979. Seasonal patterns were similar between pools with no significant recurrence of seed shrimps seen in 1980. As in previous years the seasonal pattern in egg raft numbers from these pools was similar to the pattern in numbers of *Culex* spp. females collected in two New Jersey light traps and many fewer females $(\bar{x}=2119)$ in two adjacent pools. However, whereas the two sampling methods reflected similar population declines in 1980 compared to 1979, the oviposition pools demonstrated a 6 fold increase in populations while the light traps exhibited a 2 fold decrease in 1981 compared to 1980. It is not known if this represents a bias in oviposition pools as a sampling method, a bias in New Jersey light traps or both. The species composition of egg rafts in 1981 was unusual in that a very high percentage were *Cx. restuans*. The proportion which were *Cx. pipiens* was only 13% in 1981 compared to 41% in 1980 and 32% in 1979.

To determine if the attractiveness of sod-lined oviposition sites can be maintained by replacing the sod once a season, weekly egg raft numbers were compared in galvanized metal tubs containing (A) the same sod and water all season, (B) sod and water replaced weekly and (C) the same sod and water replaced by freshly-cut sod and new water after 10 weeks, set up in a 3 x 3 latin square design. All sod, except the freshly-cut material was from one batch obtained at the beginning of the season. During the first 10 weeks, 138±15 egg rafts were collected in the A tubs, 98±9 in B and 86±12 in C. These differences are probably due to positional bias as the sod and water treatments in A and C were identical during this period. After the sod was replaced in the C tubs, 97±39 egg rafts were collected from these for the next five weeks compared to 12±5 in A and 28±11 in B. Consequently, the freshly-cut sod and new water greatly improved the attractiveness of these oviposition sites suggesting that the sod and water in such sites should be replaced at least once a season. The required frequency of replacement needs to be determined in future experiments.

5. The horizontal habitat distribution of adult mosquitoes (P. Copps, M.Sc. Student).

This study was designed to determine the distribution of Ontario mosquito species in three habitats including a woodlot, an adjacent open field and the interface between them. Traps in each habitat included a New Jersey light trap, a suction trap, a CDC light trap baited with CO_2, a rabbit-baited trap, an Ehrenberg bird-baited trap and an oviposition trap designed for *Culex* species. These were operated four nights a week from May 26 to August 28. Collections of *Mansonia perturbans* indicate that this species was ubiquitous throughout the study area. Except for the initial week of trapping, *Culex* species were most abundant at the interface and in wooded zones. Spring (snowmelt) *Aedes* species were taken most often at the interface in May and June but as the summer progressed, these species were collected mainly in the woodlot. *Anopheles* species were collected in the greatest magnitude in the field habitat. The CDC light trap was found to be the best overall trap in this study. The CDC light trap and the New Jersey light trap were equally effective for *Culex* species. The rabbit-baited trap was least productive.

6. Larval development of spring Aedes spp. mosquitoes in relation to plant phenology (R. Westwood, Ph.D. Student).

During the springs of 1980 and 1981 sampling of spring Aedes larvae was carried out in three different breeding habitats (a cedar bog, a deciduous woodland pool and an open field pool). Each pool was sampled every three days using a minnow trap, cylinder trap and bucket type samplers. Mosquito species found include Aedes provocans, Ae. stimulans, Ae. euedes, Ae. cinereus, Ae. excrucians, Ae. fitchii, Ae. canadensis and Culiseta morsitans.

Within the woodland pool, Ae. stimulans was the most numerous. As larval developmental times of all mosquito species inhabiting the pool were almost identical, Ae. stimulans was chosen as the test species for forecasting mosquito development and emergence utilizing phenological stages of selected plant species as indicators. Egg hatch occurred on February 23 in 1981 as compared to March 20 in 1980. Although the spring season appeared to be 2 to 3 weeks earlier in 1981, a total of 9 common plant species out of the 106 studied reliably indicated the period of egg hatch to 2nd instar and the period in which most larvae were 3rd instar (stage chosen for larval control) in both field seasons. The blooming of yellow daffodil and crocus coincided with egg hatch to 2nd instar of Ae. stimulans. The opening of buds and appearance of the first leaf in raspberries, clematis, cherry spp., honeysuckle, tamarack and birch spp. as well as the blooming of tulips all accurately indicated the 3rd instar stage of Ae. stimulans.

In the open field pool, Ae. fitchii proved to be the most numerous species. Larval development of the spring Aedes species in this pool was slightly faster than in the woodland pool. Reliable plant indicators of egg hatch to 2nd instar of this mosquito species were the 1-2 leaf stages of yellow daffodil and crocus. The first leaf of currant spp., clematis, raspberry, honeysuckle and cherry spp. all indicated the 3rd instar stage of the spring Aedes in the open field pool.

The cedar bog pool proved to be the most protected of the sites, having the smallest temperature fluctuations and the coolest overall temperatures. Ae. excrucians was the most common species and like the other pools, all the species in the cedar bog with the exception of Ae. provocans had similar developmental rates. For Ae. excrucians the blooming of yellow daffodil, crocus and meadow willow, as well as first leaf stages of currant spp., honeysuckle and clematis signified egg hatch to 2nd instar. The first leaf stage of tamarack, poplar, maple spp. and flowering of tulip all indicated the 3rd instar stage of spring Aedes within this site.

There seems to be very little difference in plant species acting as indicators for open field and deciduous woodland breeding areas. Within the cedar bog environment, spring Aedes species show slower development than either field or woodland pools and thus have different plant species or stages that are reliable indicators of larval development. The observations on phenological indicators will be continued in the spring of 1982. Once the most accurate plant species are established a model can be developed to provide municipal control personnel with a simple, inexpensive procedure to determine when mosquitoes are hatching and when treatment should be applied.

23. Tomlin, A.D., and Tolman, J.H. - Feasibility of using parasites and/or predators in a program of integrated control of the onion maggot.

The parasite and predator monitoring program at three of the onion growing marshes and London has now identified over 60 species of confirmed and potential arthropod predators, and seven different parasite species of the onion maggot (Hylemya antiqua Meigen) over the last two years. Hedgerows act as reservoirs and refuges for many parasites and predators, and some of these arthropods may migrate into the onion fields to prey upon or parasitize onion maggots.

A colony of Aphaereta pallipes (Say) established from 9 individuals collected at the Keswick Marsh had an LD_{50} for parathion in the F_2 of 0.00076% by direct contact toxicity compared to 0.00023% for a laboratory strain. Attempted selection of the Keswick strain at approximately the LD_{85} over 5 generations caused the LD_{50} to regress to 0.00025% by the F_7. In other words an attempt to select a resistant strain of this parasite caused what little tolerance that already existed to disappear.

The staphylinid parasite, Aleochara bilineata, had an infestation rate of 35% in onion maggots at the Pachlarz Farm, Thedford Marsh. The maximum natural infestation rate for A. pallipes was 6.2% at the London Experimental Farm.

Using a method modified slightly from that described in 1980, more than 2,000,000 A. pallipes were reared and stored for use in field dispersal and release studies. As the rate of parasitism averaged approximately 80%, parasitized H. antiqua pupae were again dispersed in the field in screened release pots. The parasite appears to enter diapause as a third instar larvae within the host puparium. Some progress was achieved in defining and utilizing conditions that induce and terminate diapause in the parasite but more work is required.

A laboratory bioassay was developed and used to test the residual effect on both H. antiqua and its parasite A. pallipes, of applications to growing onions of field rates of eight insecticides, six herbicides and five fungicides. Naled proved to be the foliar insecticide most selective for A. pallipes, mortality of exposed parasites declining to 40% two days after insecticide application. Only the herbicide chlorpropham proved toxic at field rates to the parasite, causing significant mortality for at least two days. No fungicide was toxic to either H. antiqua or A. pallipes at tested rates.

Direct contact primary screening tests on adult laboratory reared Aleochara bilineata, a staphylinid parasitoid of H. antiqua, have been completed for 20 insecticides and insect growth regulators. Parathion was the most toxic insecticide tested, followed in order by fensulfothion, chlorpyrifos and diazinon. Fonofos, the least toxic commercial insecticide, proved 100x less toxic than parathion. Organochlorine insecticides and the insect growth regulators exhibited relatively low toxicity to the staphylinid.

A 50 m x 12 m block was established in one corner of a commercial onion field on the Thedford-Grand Bend marsh. Chlorfenvinphos 5G was applied as a seed furrow treatment; no other insecticides were applied throughout the summer. Beginning May 25, 1000 parasitized pupae were distributed each week for 13 weeks among 10 release pots in the block. In addition, four one square metre beds of sliced onion halves seeded with H. antiqua eggs were established on four occasions in an attempt to increase the population of predators and/or parasites in the block. Examination of collected H. antiqua pupae revealed A. pallipes was not an effective parasite during high summer temperatures. Laboratory experiments subsequently identified 20-25°C as the optimum temperature range for effective parasitism by A. pallipes. A. bilineata was confirmed as an effective parasitoid under summer conditions, attacking as much as 33% of one sample of pupae collected from the block. Predators and parasites alone did not effectively control destruction of onions by first generation onion maggot; 53.8% of plants were lost. Application of chlorfenvinphos 5G reduced plant loss to 16.5%.

Foliar application of parathion by the grower to adjacent areas of the same onion field further reduced loss to 6.9%.

In mid-August, 0.2 ha release blocks were established on two fields of recently harvested pickling onions. Control sites were set up in adjacent upwind fields. Very heavy rains and flooding forced relocation of both blocks in early September; one of the new locations was then flooded in late September. Twenty release pots were established on each block. Parasitized pupae were distributed at a rate of 250 pupae/pot/release (5,000 pupae/block/release) on the Donald block and 500 pupae/pot/release (10,000 pupae/block/release) on the Carrothers block. Four weekly releases were made beginning September 8.

In spite of weather problems some data were obtained. Rates of parasitism were established by a) extracting *H. antiqua* pupae from "micromountains" (0.25 m^2 onion maggot mass rearing beds) and b) extracting pupae from 1.0 m rows of sprouted pickling onions infested with *H. antiqua* eggs. Pupae collected by method b) are in storage and will be checked for parasitism in January. Parasitism in pupae collected by method a) showed significant elevation in rates of parasitism when maggots were exposed to released *A. pallipes* after September 23. Parasitism, however, was not as high as in 1980; the maximum recorded was 6.5% on the Carrothers block. Doubling the rate of release more than doubled the resulting parasitism. Pupae collected in early September from the Donald block by method a) showed very significant 41% parasitism by the natural population of *A. bilineata*.

24. Tu, C. M., and Miles, J.R.W. - Influence of environmental factors on the rate of microbial degradation of pesticides in soil and water.

An experiment to study the effect of temperature on the persistence of chlorpyrifos (Lorsban (R)) and chlorfenvinphos (Birlane (R)) was begun in November 1981. Since the experiment is designed to run for 24 wk, extraction of samples will not be completed until April 1982. The two insecticides were separately applied to natural sandy loam and muck, and also to sterile sandy loam and muck. Treated and control samples have been stored in darkness at 3, 15 and 28°C. Sampling was done at 0, 2, 4, 8 and 16 wk and analyses are proceeding.

25. Wukasch, R.T. - Effect of companion planting on pests in the home garden.

Research continued for a third and final growing season to complete a long-term assessment of methods of companion planting for pest control in the home garden. Various companion plants were interplanted around and within plots of cabbages, potatoes, and roses. Cattle manure, bone meal, and composted leaves were used as soil amendments, while mulches and cultivation were used for weed control. No pesticides were used during the growing season except those applied to sprayed plots in each experiment.

Companion plants included chives (*Allium schoenoprasum*), garlic (*Allium sativum*), dill (*Anethum graveolens*), catnip (*Nepeta cataria*), parsley (*Petroselinum crispum*), tansy (*Tanacetum vulgare*); crops such as celery, snap bean, and tomato; and ornamentals such as geranium (*Pelargonium hortorum*), marigold (*Tagetes patula*), and nasturtium (*Tropaeolum majus*). Unsprayed and sprayed control plots were also included in each experiment, replicated four times. Pest and disease levels were evaluated by visual and sweep net samples, and crop yield and quality was assessed.

Potatoes:

In spite of increased sample size in 1981, no companion plant significantly affected potato pests or diseases. Beans, as in 1980, influenced pest levels more than any other companion treatment. Significantly less leaf injury due to Colorado potato beetle (CPB) and potato leafhopper (PLH) feeding occurred in the bean treatment when compared to the unsprayed control. However, despite reductions in numbers of CPB (57%), PLH (31%), and aphids (53%), and increased numbers of tarnished plant bugs (TPB) (47%) and potato flea beetles (96%) in the potato crop, none of these changes were statistically significant. Excellent control of the PLH, CPB, and TPB was obtained in the sprayed plots throughout the growing season. Sprayed plots also produced 2 1/2 times more total and marketable potato yields than did the unsprayed counterparts. Yields in all companion treatments were very similar to the unsprayed control.

Cabbage:

As in previous years, cabbage pests such as the imported cabbageworm (ICW), diamondback moth (DBM), and aphids were mostly unaffected by companion plants. Though increased oviposition by the ICW was observed, significant control of ICW and DBM larvae was only achieved in the sprayed plots. Crucifer flea beetle (CFB) populations on cabbages were significantly reduced by companion plants with abundant foliage and the sprayed treatment, whereas sparsely foliated plants such as dill and garlic had little effect. Highly competitive companion plants such as tansy, marigold, dill, tomato, catnip, and celery reduced cabbage yield and quality. Only the sprayed cabbages produced an acceptable, marketable yield.

Roses:

Aphid populations were highly variable, and were fewest in the sprayed plots. Chives, while significantly reducing PLH levels in roses, also severely curtailed flower production. No other companion plants affected pest populations or flower yield. Companion plants had negligible effect upon black spot and powdery mildew in 1981.

Pest levels, crop yields, and quality of crops planted with companion plants were generally unacceptable in 1981. Potential trade-offs could be realized in harvesting the companion crop such as beans or tomatoes. However, inter-specific competition and inadequate pest control were key factors in reducing the potential of this method of non-chemical pest management.

APPENDIX IV. Publications and theses relating to Ontario Pesticides Advisory Committee Research Programs, April 1, 1981 - March 31, 1982

Bodnar, J. M. 1981. Some effects of the spotted tentiform leafminer, Phyllonorycter blancardella (F) on apple tree physiology. M. Sc. thesis presented to the Faculty of Graduate Studies, University of Guelph.

Chapman, R. A., C. M. Tu, C. R. Harris and C. Cole. 1981. Persistence of five pyrethroid insecticides in sterile and natural, mineral and organic soil. Bull. Environ. Contam. Toxicol. 26: 513-519.

Chapman, R. A. and C. R. Harris. 1981. Persistence of four pyrethroid insecticides in a mineral and an organic soil. J. Environ. Sci. Health B16: 605-615.

Chapman, R. A., C. M. Tu, C. R. Harris and Carol Harris. 1982. Biochemical and chemical transformations of phorate, phorate sulfoxide, and phorate sulfone in natural and sterile, mineral and organic soil. J. Econ. Ent. 75: 112-117.

Dufault, C. P. 1982. Control of the adult cabbage maggot, Hylemya (= Delia) brassicae (Wied.) on rutabagas with insecticidal baits. M. Sc. thesis presented to the Faculty of Graduate Studies, University of Guelph.

Harris, C. R., R. A. Chapman and Carol Harris. 1981. Laboratory studies on the persistence and behaviour in soil of four pyrethroid insecticides. Can. Ent. 113: 685-694.

Helson, B. V. and G. A. Surgeoner. 1982. Permethrin as a residual lawn spray for adult mosquito control. Mosquito News. In Press.

Hildebrand, P. D. and J. C. Sutton. 1982 Weather variables in relation to an epidemic of onion downy mildew. Am. Phytopathological Soc. Vol. 72. No. 2. 219-224.

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